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Abstract
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Abstract

Socio-economic changes occurred after World War II have resulted in a dramatic agro-pastoral abandonment with an extended shrub and tree encroachment of Italian mountain grasslands. This phenomenon has affected either the temperate and Mediterranean mountains, where invasion is the first step of the ecological succession towards the potential forest vegetation (Bagella et al. 2017). Biodiversity loss (Bagella et al., 2016; Orlandi et al., 2016), increase of wild-fires, erosion and avalanches over large areas (Pittarello et al. 2016) are the main effects of changing vegetation. As a consequence, the conservation and restoration of semi-natural grasslands have become important agri-environmental issues. Recent researches show the benefits of the strategic placement of mineral mix supplements (MMS) to lure cattle into traditionally undergrazed areas and restore sub-alpine shrub-encroached grasslands (Probo et al. 2014; Pittarello et al., 2016). Due to the combined effects of grazing, trampling, seed transportation, and nutrient redistribution by cattle, these practices were effective in temperate grasslands in reducing invasive plant cover and in increasing the cover of herbaceous species characterized by good forage quality, while enhancing the diversity of plants and some insect taxa at the same time. The present work, which is part of in progress project iGral[1], has the ultimate goal of defining innovative options for the development of sustainable sylvo-pastoral systems. Here we report the first results on the strategic use of MMS in a sylvo-pastoral rangeland at Mediterranean mountains in Sardinia.

The study was conducted in the experimental farm of the Agricultural Research Agency of Sardinia (AGRIS Sardegna), located in municipality of Macomer (Nuoro, 600-700 m asl; lat.40°233N, long. 8°702E), as representative of sylvo-pastoral areas in Mediterranean mountains. The area is encroached mainly by downy oaks (Quercus pubescens Willd.) and shrubs of Pruno-Rubion and Cytisetea scopario-striati (Ruiu et al., 2017). Secondary grasslands are represented by communities referable to the classes Poetea bulbosae (habitat 6220*), Molinio-Arrhenatheretea and Stellarietea mediae (Bacchetta et al., 2007). The study area consisted of a pasture (40 ha) managed under a continuous stocking system and grazed by a herd of 12 mature Sarda suckler cows with their calves (16.7 AU - Allen et al., 2011), at a stocking rate of 208 kg live weight/ha. Nine MMS were supplied in 5-kg blocks (fosfatic salt blocks, Sivam), which were placed on metal poles arranged along a line of 252 meters, in traditionally undergrazed and shrub-encroached locations. The linear arrangement of poles rather than a clustered one was used to help cows spread across these underutilized areas and find all the MMS sites (Pittarello et al., 2016). A paired

[1] Ager 2 Mountain Agriculture programme – project iGral "Innovative beef cattle Grazing systems for the Restoration of Abandoned Lands in the alpine and Mediterranean mountains"

control site without any supplement (C) with similar vegetation and topographic conditions was identified for each MMS site at a distance of 104±53 m. (mean ± SD). Three randomly selected cows were tracked with Global Positioning System (GPS) collars during period 15- 25/07/2019. Knight GPS tracking collars, based on igotU Gt – 600 GPS units equipped with a large size rechargeable battery pack were used (Knight et al. 2018). The manufacturer reports an average accuracy of acquisitions within 10 m. Positions were recorded every 3 min. MMS and C locations were recorded with a hand-held GPS (Garmin Oregon ® 650t, Maps Trekmap ® Italia v4 pro). The use of sites by cattle was evaluated by fix count in a 50 m buffer around MMS and corresponding C poles. The use of MMS (time spent within 50- m buffer area) and corresponding C were compared with generalized linear mixed model. The experimental unit was the 50-m buffer area. The model included site type (supplement or control) as fixed effects and MMS pole as random effect. GLMM analyses were performed using the nmle R package of R, version 3.6.1. (R Development Core Team, 2012).

During the experiment, a total of 17597 fixes was recorded, corresponding to 91% acquisition rate. The collared cows walked, on average, 6999±1771 m daily (mean ± SD). The MMS showed some ability to attract cattle, having the grazing cows visited more MMS sites than their related C sites (Table 1). The cattle tracking lasted only 10 days and the number of visits was small, consequently. Moreover, the results about the effects of cattle on vegetation will be available only after monitoring over a larger time span. However, preliminary achievements seem to confirm the results obtained in temperate grasslands under different vegetation conditions and with different cattle breeds.

Table 1. Number of visits of cows to MMS and C sites from 15 to 25/07/2019

	MMS site (n)	C site (n)	P value
Time spent within 50- m buffer area per cow (min)	103.1 ± 16.3	57.6 ± 16.3	0.04

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